Discussion on Training Students' Ability to Solve Complex Engineering Problems from the Perspective of Professional Certification

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Abstract. China formally joined the "Washington Accord" and China's engineering education ushered in new opportunities and challenges. In order to meet the requirement of "the ability to solve complex engineering problems", we take the profound teaching reform and the actual project as the background and take the engineering technology as the main line. We should continue to enhance the students' practical ability. The development of new professional certification standard can improve the level of engineering education at institutions of higher learning and enhance the international recognition and competitiveness of graduates. In professional accreditation, we should pay attention to the cultivation of students' abilities to solve complex engineering problems, that is, students are required to transform from learning book knowledge to solve practical problems, which is in line with the idea of Outcome-Based Education.

Keywords: Complex engineering problems · Professional certification
Engineering education · Practical ability

1 Introduction

"Engineering education certification work guide" issued by China Engineering Education Professional Certification Association: The teaching process of undergraduate engineering education needs to be oriented to "complex engineering problems". Under the new situation in which the demand for innovative talents and advanced engineering technicians in the country has risen sharply, the Ministry of Education has carried out many engineering education reforms in practice, such as the excellent engineer education and training program, the construction of CDIO [1]. How to cultivate students' ability to solve complex engineering problems has become an important issue in engineering education.

From the perspective of setting up teaching links in undergraduate course teaching, project-based practical teaching and practical activities are highly significant links [2]. It is a comprehensive link for the professionals to achieve the goal of personal training. It is a comprehensive innovative practice and a professional certification for graduation

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required the degree of achievement, which has a strong supportive role in the course. With the goal of R&D, design, experiment and production, students should learn and solve engineering problems in an active, which can enhance their knowledge of the project, cultivate students' basic knowledge of engineering, personal skills, interpersonal skills and teamwork Engineering System Capabilities to further enhance students' ability to solve complex problems. This article focuses on the analysis of the specific connotation of complex engineering problems and puts forward some plans to train students to solve complex engineering problems, with a view to gradually improve undergraduate practical ability [3].

2 Constructing a Scientific Practice Teaching System

The result-oriented education is a kind of educational idea guided by the achievement-oriented learning of students. The goal of instructional design and teaching is that the students finally achieve the learning outcomes through the educational process [4]. The core point is that students become "masters of learning". Aiming at the ability to solve complex engineering problems, this paper constructs a communication practice teaching system scientifically and reasonably. As shown in Fig. 1.

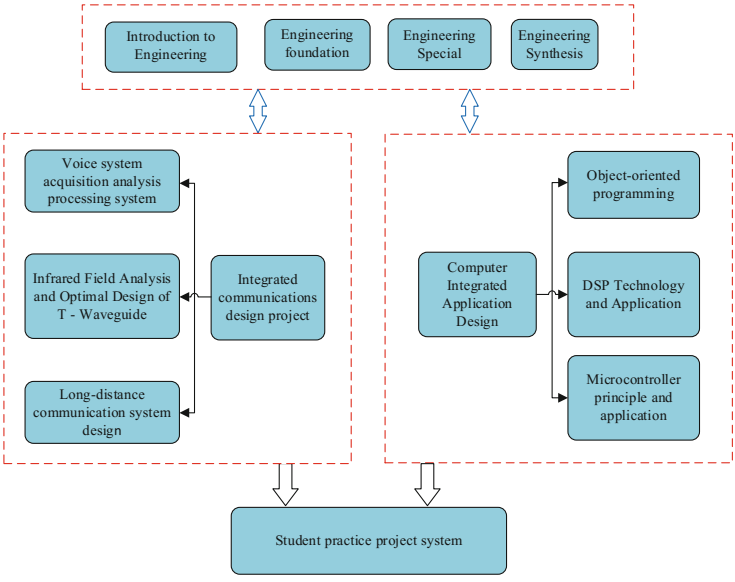

Fig. 1. Student practice project system

The practice teaching system of communication is divided into the following aspects. Engineering practice includes basic experiments such as physics and other basic experiments and circuits. It focuses on cultivating students' good practice habits

and the concept of learning to apply, cultivating students' rigorous learning attitude and meticulous working habits, and achieving the training of students' basic engineering practice ability; The practice of engineering technology is carried out according to basic engineering training and comprehensive engineering training; Comprehensive practice includes production practice, professional design, technological innovation activities, etc., which can cultivate students' good engineering quality, engineering norms, engineering awareness and engineering practice ability [5].

During the four years' study, students undergo a series of practical activities such as teaching experiment, curriculum design, professional practice and graduation design, and most of them have special training or practice every semester. In 2015, in the practice of electromagnetic field and microwave course, we added the discussion of the current distribution of rectangular section metal waveguide wall based on "Coulomb's law and Biot-Savart law". And in 2016, the design and implementation of the automatic temperature control system were added to the practice of Microcomputer Principle course.

3 Training Students' Ability to Solve Engineering Problems

The electronic information engineering specialty taught by the author is an excellent pilot project. The author conducted a three-level project curriculum reform plan and added the corresponding course. During the process of writing the self-assessment report on professional certification, we have deepened our understanding of the complex engineering problems in graduation design and explored innovative ideas to enhance undergraduates' ability to solve complex problems by the reform of professional teaching. The author conducted a three-level project curriculum reform plan and added the corresponding course. Teachers design different projects according to the content of the course, assign project topics to students and four or five students in each group, students team members conceive, design, implement and operate the project together and finally according to the student's overall performance score. The project to learn the basic methods to solve complex engineering problems, which are to solve the core of complex engineering problems, lay the foundation for students to move to work eventually.

Based on this, through the actual project implementation, students can sort out the basic principles, basic knowledge and basic skills of the course they have learned while in school, and establish an appropriate abstract model through in-depth engineering principle analysis [6]. Most of the engineering students are engaged in solving practical engineering problems. Display complicated factors as engineering problems, and reasonably simplified them as scientific problems with mathematical models. This not only enables them to learn the basic process of solving engineering problems through curriculum knowledge through actual engineering projects but also help to develop students' team awareness and academic communication skills. Training students to solve complex engineering problems, but also lay a solid foundation for their future jobs.

3.1 Construction of Practical Engineering Environment

As the state pays more attention to engineering students' ability to solve practical engineering problems, related universities in China have studied how to improve students' practical ability. Although there are different research angles in colleges and universities, there is a common problem that the overall practice environment can't meet the training program [7]. In particular, the lack of advanced commercial equipment and technology systems has let students simulate related experiments only through software simulation. Inaccessible to the latest real equipment, engineering practice skills such as empty talk.

In the view of the requirements of professional certification for the ability training of complex engineering problems, combined with the specialty of communication specialty and the development trend of the industry, the author's institutions successively cooperated with Huawei Communication Technology Co., Ltd. and Ruijie Networks Co., Ltd. to carry out the cooperation between school and enterprises based on the technical equipment of enterprises advantages, in deepening the capacity of student engineering practice to discuss training mechanism, formulated a number of personal training program. Undertook such as "Huawei Cup Electronic Design Competition", internships and other practical activities. In recent years, the hurricane software innovation laboratory created by our university has achieved some achievements by the enterprises putting into the project funds each year and adopting the engineering management mode. Currently developed by Wantong Universal Financial Software.

3.2 CDIO Engineering Teaching Philosophy to Improve the Teaching

The traditional teaching model adopts the inculcating education method, pays attention to the students' academic achievement but ignores the students' application ability, the design ability. In order to cultivate students' abilities to solve complex problems, this paper proposes the CDIO teaching concept, namely conceive, design, implement and operation [8]. Taking the life process of products as the train of thought, from design and development of research and development to actual assembly and off-line application, students' engineering design ability, engineering management ability and innovation ability are exercised throughout the whole process so that students can understand the current enterprises' Problems in the processes and methods. The CDIO teaching model is oriented toward engineering design and aimed to cultivate practical ability. Students can take the initiative to participate and practice through the organic combination of course. Specific project implementation plan is shown in Fig. 2.

In the concept session, teachers put forward the project requirements. Students collect information to complete the project needs analysis, teachers comment on the students' project analysis, and gradually improve students' ability of independent thinking during the interaction. During the design process, students should take the initiative to analyze the needs of the project according to the concept. By consulting the data resources such as dissertations and technical resources, the overall design of the project is designed. The teacher mainly analyzes the feasibility of the project. This process can train students' design ability. In the implementation process, the students at

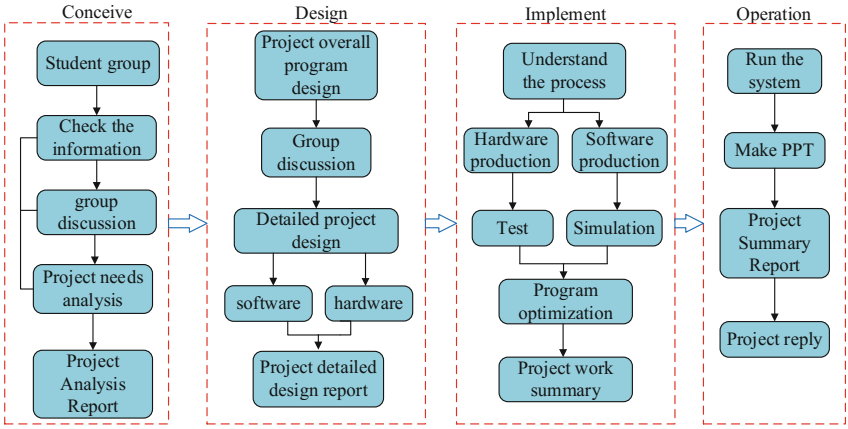

Fig. 2. CDIO-based project implementation process

the laboratory site implementation, including the entire process, hardware equipment building, software debugging, system debugging, program optimization and other sectors. Finally, to complete the project implementation summary reports writing. This process is mainly to cultivate students' practical ability, teamwork ability and so on. In the running session, teachers should check the quality of the project and analyze the problems that occur in the student project to ensure the reliability of the project implementation. Finally, the results show this process fosters students' ability to communicate and synthesize.

3.3 Establish a System of Assessment

In order to effectively cultivate students' ability to solve practical engineering problems, all aspects must be close to the actual project. Therefore, the core of the assessment mechanism is how to evaluate students' ability to solve practical engineering problems. This requires organizational units and mentors to strictly enforce process monitoring [9].

Specific Requirements in the practice of the project, first of all, strengthen the management of the practical aspects of the project topics, open questions, mid-term inspection, project reply and performance evaluation and other aspects of the project to ensure the orderly conduct of the project. Strictly require students to take project practice seriously, while strengthening management of students should also strengthen the management of the instructor, to seriously examine the work of the instructor, to check the quality of their guidance. In addition, graduates of the outstanding performance of the design of the students and instructors rewards, but for those who can't meet the requirements of graduate design guidance teachers and students should be punished to some extent, so as to form a fine style of study and graduation design tradition and enable students to graduate the beginning of the design is not lucky.

Since 2014, the author unit has conducted outstanding project practice exhibitions, and all teachers and junior students are encouraged to vote. During the review process,

all of the design prototypes and design prototype system to be examined. Personally, for students participating in practical projects, the author sets out the clear requirements of the project at the beginning of the project. As long as the students have reached the project design goals and demonstrated in the project team, they will complete the project practice. In this end, let students develop a graduation design timetable, require students to complete the task in strict accordance with the time node. Form a weekly report system. This system is a warning to some of the more inert students. Through these practices, students can gradually improve their ability to solve complex engineering problems.

4 Conclusion

The ability to solve complex problems is an important part of undergraduate training, and which an inevitable requirement for students to practice and innovate. In the field of education, the vast majority of front-line teachers backbone and have a major responsibility. Hoping that through in-depth study of undergraduate expertise during the study for students to lay a solid foundation for work. Fully mobilizing the enthusiasm of instructing teachers and students and strengthen the effective management of all intermediate links to students' learning and life so as to develop students' ability to solve complex system problems and improve students' practical ability.

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References

1. Zhou, K., Luo, C., Kang, M.: Implantation of "complex engineering problems" teaching system reform and exploration. Chin. Univ. Teach. (314), 51–54 (2016). (in Chinese)
2. Li, Y., Wang, H., Wu, Y., Dong, P.: Construction of diversified practical teaching system facing the ability of solving complex engineering problem. Cult. Educ. Mon. (741), 186–188 (2017). (in Chinese)
3. Hu, Z., Xu, C., Li, Y., Li, G.: Three level project design of engineering courses from the perspective of professional certification. J. Teach. Res. **40**(176), 96–99, 105 (2017). (in Chinese)
4. Gu, P., Hu, W., Lin, P., Bao, N., Lu, X., Xiong, G., Chen, Y.: Engineering education model based on OBE-practice and exploration of Shantou University. High Eng. Educ. Res. (144), 27–37 (2014). (in Chinese)
5. Feng, M., He, X., Luo, X., Zhou, X.: An innovative teaching system for practice measurement and control based on CDIO concept. Lab Res. Explor. **33**(217), 180–184 (2014). (in Chinese)
6. Wang, X., Feng, H., Li, X.: Exploration of communication engineering innovative talents cultivation system with excellent engineers. Ind. Technol. Forum. **15**, 266–267 (2016). (in Chinese)
7. Sun, A., Fan, J., Zhao, X.: Practice teaching reform and cultivation of students' engineering practical ability under the background of excellence. China Univ. Teach. (274), 79–80, 87 (2013). (in Chinese)

8. Yang, Y., Meng, B., Wang, W.: How to solve the difficulties of "complex engineering problems" in engineering education-based on the enterprise technology innovation perspective. High. Eng. Educ. Res. (274), 72–78 (2017). (in Chinese)
9. Yang, W., Liu, W., He, X.: Research on training model of electrical excellence engineer for engineering education certification. J. Exp. Technol. Manag. **34**(246), 16–19, 31 (2017). (in Chinese)